Taxpayers Attitudes Toward Risk and Amnesty Participation: Economic Analysis and Evidence for the Italian Case*

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Abstract

This paper provides a simple model, based on expected utility theory, for rationalizing taxpayer's reaction to an unexpected amnesty offer. The model is estimated through a deterministic approach, with reference to data pertaining to the 1991 and 1994 Italian tax amnesties. Results seem sound and suggest that standard critiques to the use of expected utility theory for describing taxpayer behavior do not apply when participation in amnesties is considered. However, the model fails in explaining the behavior of full compliers (who refuse the amnesty). Their behavior can be better rationalized by resorting to the expected utility with rank dependent probability approach.

Keywords: tax amnesty, plea bargaining, risk aversion, Italian tax system.
JEL Classification: D81, H26.

1 Introduction

This paper models taxpayers reactions to a tax amnesty that has the following characteristics:

i) it occurs after reports have been made and before audits begin;

ii) it is not anticipated by taxpayers;

iii) it may be entered by paying a fixed amount in order to avoid tax audits.

In Italy there have been amnesties in which a fixed payment was requested. They were termed "burial", as participants did not need to amend their income report, but just pay a fixed amount.

Economic theory of plea bargaining explains why the tax administration could renounce the auditing and the applying of sanctions to taxpayers who agree to make additional fixed payments.

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Chu [8] has pointed out that a system offering taxpayers the possibility of making a fixed payment to avoid tax audits resembles plea bargaining in criminal proceedings. They both provide opportunity for avoiding controls (i.e. audits for taxpayers and trials for the accused) and the sanctions that may follow, in exchange for a compensation. The consequences, under given conditions, are beneficial for social welfare. More specifically, according to Grossman and Katz [16], plea bargaining performs a "just" selection. The indicted guilty accept to plead guilty, whereas the innocent ones go to trial. The amnesty considered in this paper selects "big evaders", that is, people whose evasion lies above a given threshold, and extracts resources from them.

The paper provides a simple model for calculating the extra payment that a taxpayer, who partially evaded the income tax but has not been audited yet, would agree to make in order to regularize his position.

The model of taxpayer behavior, based on the Von Neumann-Morgenstern expected utility theory (EU), is presented in Section 2. This model is used in Sections 3 and 4 to estimate, through a deterministic approach, the evaded income and the risk aversion of the marginal taxpayer who accepted the amnesties offered by the Italian tax administration in 1991 and in 1994. In Section 6 alternative estimates are calculated with reference to the EURDP (Expected Utility with Rank Dependent Probability) approach[1] (see, e.g. [10]). All estimation results are discussed in the Concluding Remarks.

The main finding of the paper is that EU works reasonably well for describing the behavior of amnesty participants. However, like in standard economic analysis of taxation, an (untenable) assumption of infinite risk aversion would be needed for describing through the same model the behavior of full compliers (who refuse the amnesty). EURDP, coupled with social motivations, performs better to model the behavior of full compliers. Agent's heterogeneity could explain why each model considered applies only to a subset of taxpayers.

2 The Risk Averse Tax-Evader

Let us consider a taxpayer who has an exponential utility function

$$u(w) = -e^{-\alpha w}$$

with constant absolute risk aversion $\alpha > 0$, and increasing relative risk aversion. The choice of such a function is mainly dictated by analytical convenience. At any rate, increasing relative risk aversion has been found to be in accordance with data for assets pricing [20] and for bids in the Treasury bill auctions [25]. As far as taxation is concerned, increasing relative risk aversion, and thus decreasing proportional evasion, is supported by some empirical evidence (e.g. [4]) and is in accordance with the widely shared opinion that richer people largely resort to legal tax avoidance as a substitute for tax evasion.

Let us introduce the ingredients for setting up a decision model describing the behavior of a rational taxpayer who partially evades his income tax. We denote by W the taxpayer's true taxable income and by X the reported income. A progressive tax system is considered, where the income

[1] EURDP assumes that the agent arranges the outcomes (in this case: net income levels) in increasing order, and has a perception of the probability of their occurrence deformed according to their rank. This may lead to an overestimation of small probabilities of facing disappointing outcomes. Specifically, in the field of taxation, it produces an overestimation of the probability of being detected, which may motivate a larger compliance.

tax is approximated by the following function:

$$T(X) = \gamma X^{\delta}, \tag{1}$$

where $0 < \gamma < 1$ and $\delta > 1$ are parameters such that, for each given W, $W > \gamma X^{\delta}$; *i.e.*, the true income must always be higher than the amount of tax to be paid. This implies that our model is defined for $0 < W < \gamma^{-\frac{1}{\delta-1}}$. W is assumed to be exogenous[2] and such that $W \geq X$. We assume that the taxpayer who chooses to evade taxes, while filling in his income tax form, ignores the possibility that a tax amnesty may follow. Therefore, he maximizes his expected utility

$$E\left[U\left(X\right)\right] = \left(1-p\right)\left[-e^{-\alpha\left(W-\gamma X^{\delta}\right)}\right] + p\left\{-e^{-\alpha\left[W-\gamma X^{\delta}-g\gamma\left(W^{\delta}-X^{\delta}\right)\right]}\right\} \tag{2}$$

with respect to X, where $0 < p < 1$ is the audit probability and $g > 1$ is a penalty rate[3].

Since we are considering only partial evaders, the optimal amount of income reported X^{*} must lay in the interior of interval $(0, W)$. Thus, utility maximization is completely described by F.O.C.:

$$X^{*} = \left\{W^{\delta} - \frac{1}{\alpha g \gamma} \ln\left[\frac{1-p}{p\left(g-1\right)}\right]\right\}^{\frac{1}{\delta}}. \tag{3}$$

To guarantee interiority, on the one side full evading $X^{*} = 0$ must be avoided, that is,

$$W^{\delta} > \frac{1}{\alpha g \gamma} \ln\left[\frac{1-p}{p\left(g-1\right)}\right] \tag{4}$$

must hold; while, on the other side, we need to exclude full compliance $X^{*} = W$ (in which case no additional payment would be made), which translates into

$$\frac{\left(1-p\right)}{p\left(g-1\right)} > 1, \tag{5}$$

that reduces to $p < g^{-1}$.

Now suppose that, before the taxpayer has been audited, the tax administration offers him the possibility of paying the fixed amount C in order to avoid with certainty any applicable sanction. Ignoring, for the sake of simplicity, inter-temporal discounting, and assuming that no other relevant variables (e.g., taxable income, penalty rate, etc.) has changed in the meantime, the taxpayer will accept the offer if he is at least indifferent as whether to pay the amount C or stay in his position of partial evader. Thus, for a positive reaction, the following condition must be met:

$$\begin{aligned} -e^{-\alpha\left(W-\gamma X^{*\delta}-C\right)} \quad \geq \quad & \left(1-p\right)\left[-e^{-\alpha\left(W-\gamma X^{*\delta}\right)}\right] \\ & + p\left\{-e^{-\alpha\left[W-\gamma X^{*\delta}-g\gamma\left(W^{\delta}-X^{*\delta}\right)\right]}\right\}. \end{aligned} \tag{6}$$

If the indifference condition holds, that is when equality holds, the left hand side can be seen as the utility of the evader who makes the additional payment, while the right hand side is the expected

[2] This strong assumption, made for the sake of simplicity, rules out any direct effect of taxation upon decisions about work and leisure, and also the indirect effects of the expenditure of tax revenue.

[3] Here, parameter g substitutes the more widely used term $(1+s)$: i.e., as in standard tax evasion models, the detected evader has to pay both the due tax and the penalty s times the evaded tax.

utility of the evader who does not. Obviously, to meet this condition, the extra payment C must be lower than the sanction:

$$0 < C < g\gamma \left(W^{\delta} - X^{*\delta}\right). \tag{7}$$

The full problem of a taxpayer who meets the conditions for participating in the amnesty is thus completely described by the following system:

$$\begin{cases} X^* = \left\{W^{\delta} - \frac{1}{\alpha g \gamma} \ln\left[\frac{1-p}{p(g-1)}\right]\right\}^{\frac{1}{\delta}} \\ -e^{-\alpha\left(W-\gamma X^{*\delta}-C\right)} \geq (1-p)\left[-e^{-\alpha\left(W-\gamma X^{*\delta}\right)}\right] \\ \qquad\qquad +p\left\{-e^{-\alpha\left[W-\gamma X^{*\delta}-g\gamma\left(W^{\delta}-X^{*\delta}\right)\right]}\right\} \end{cases} \tag{8}$$

This is a static model where the agent, represented by a given utility function, faces two gambles: the tax evasion lottery and the amnesty lottery[4].

Under conditions (4), (5) and (7), the system (8) can be solved for variables α and W. In fact, the second inequality can be simplified into $e^{\alpha C} \leq 1 - p + pe^{\alpha g \gamma\left(W^{\delta}-X^{*\delta}\right)}$ and thus, by substituting $X^{*\delta}$ from the first equation, after some algebra we obtain the following condition for the absolute risk aversion:

$$\alpha \leq \frac{1}{C} \ln\left[\frac{g\,(1-p)}{g-1}\right] = \hat{\alpha}.$$

Hence, in view of the first equation, the true taxable income will satisfy:

$$W \geq \left\{X^{*\delta} + \frac{C\left[\ln(1-p) - \ln p - \ln(g-1)\right]}{g\gamma\left[\ln g + \ln(1-p) - \ln(g-1)\right]}\right\}^{\frac{1}{\delta}} = \hat{W}. \tag{9}$$

Note that, thanks to the assumption of constant absolute risk aversion, only risk aversion parameter α matters: taxpayers interested in accepting the offer must have an absolute risk aversion equal to or lower than the threshold $\hat{\alpha}$. More risk averse taxpayers do not evade enough to make the additional payment C worthwhile for them. Consequently, from (9) it follows that, for a given value of X^*, participants will have a true income W equal to or higher than the threshold $\hat{W}$, that is, their percentage evasion must be equal to or higher than $\hat{W}^{-1}(\hat{W} - X^*)$.

To facilitate comparison with available empirical evidence, in the following sections we calculate the relative risk aversion $\hat{\alpha}(\hat{W} - \gamma X^{*\delta})$ of marginal amnesty participants. Recall however that, with an exponential utility function, relative risk aversion changes with income, and thus the calculated relative risk aversion is referred to the income level $(\hat{W} - \gamma X^{*\delta})$ that the taxpayer has when the amnesty is offered.

The mechanism considered in the model is reminiscent of plea bargaining for criminal offenses. Offer C, indeed, selects "guilty" taxpayers (those who evaded amounts high enough to justify participation), and is refused by "innocent" ones (those who evaded smaller amounts).

As C increases, the threshold true income increases. Thus there is a trade-off between raising amnesty revenue from a few rich participants (with high individual payments) or from virtually all the tax evaders (with small individual payments).

[4]Tax reporting and partecipating in amnesties provide a sort of natural experiment that parallels a tecnique widely used in laboratory, where in a session participants face many lotteries, and their reactions are used to infer their preferences. For a recent example, see [18].

The model is oversimplified in assuming that taxpayers are not at all aware that a new offer will be made when they fill in their tax report. If, on the contrary, taxpayers were to perfectly anticipate the future amnesty offer, they could take the maximum benefit from it by reporting nothing. That is, taxpayers would consider the amnesty as an alternative to tax compliance, and either participate in the amnesty while reporting nothing, or ignore the amnesty altogether, reporting as much as in equation (3), depending on whether the level of C satisfies (6) or not. Reality is probably somewhere in between these two cases. Models that consider taxpayers' anticipation (see for example [1] and [6]) generally predict greater tax evasion and larger amnesty participation than with unanticipated amnesties. Therefore, one may argue that the true risk aversion of the marginal participant will be somewhat higher than $\hat{\alpha}$, since also more risk averse taxpayers dare to evade something when they feel that an amnesty is likely to occur.

3 The 1991 Tax Amnesty

Italian Law no. 413/1991 introduced a general tax amnesty regarding the main Italian taxes. This amnesty was considered a success in terms of participation and revenue. Revenue (collected in the years 1992 and 1993), well above government forecasts, amounted to about 7,000 million US dollars (1998 exchange rate). Participation was highly concentrated among taxpayers with self-employment and business income (where it encompassed 40% of those who had filed a tax report), while it was scanty among wage earners.

3.1 Parameters of the Model

In the followings, we assess the values of the parameters needed to solve system (8).

To elicit parameter C, let us consider the provisions of amnesty law pertaining to the income tax. For taxpayers not yet audited, par. 38 dictates rules for calculating the extra payment necessary to enter the amnesty (i.e. for calculating C). They are summarized in Table 1. In order to extract each taxpayer's willingness to pay, the Italian legislator tried to appropriately fix different amounts of C, exploiting the information conveyed by his income report. As a result, C turns out to be an increasing function of reported income X^* (see Figure 1).

Table 1 ***Rules for calculating payment*** C ***in the 1991 Italian Tax Amnesty***

Brackets of paid tax	***Extra payment due***
0 - 10	*20% of the paid tax (with a minimum of 0.1millions of Italian Lire))*
10-40	*18% of the paid tax*
>40	*15% of the paid tax*

Note: the fixed minimum payment (for zero paid tax) was higher for business and self-employment income.

Payment C was due for each year for which the amnesty was entered, from 1985 to 1990. Taxpayers were to participate for all the years covered by the amnesty in which they had not been audited (a kind of tying). Those who had not filled in an income report could not participate in the amnesty.

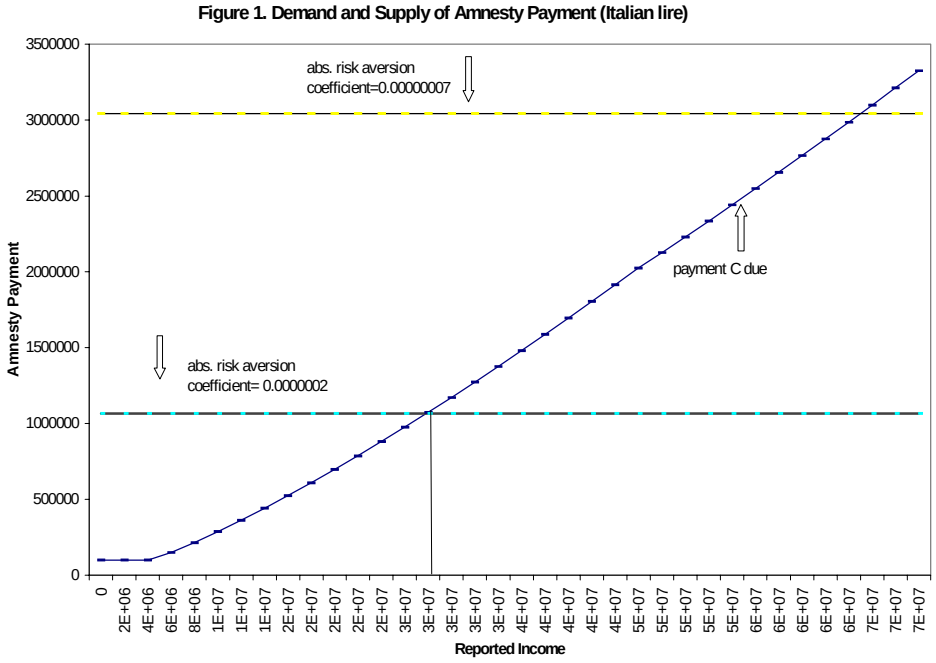
To calculate C for a taxpayer who reported a given income, we need to calculate his income tax, according to function (1). Parameters γ and δ of function (1) have been estimated with reference to the income taxes due per income bracket, for each year for which amnesty could be entered: they are reported in the Appendix.

Let us consider now parameter g. When found guilty of tax evasion, the taxpayer also often bears costs besides monetary sanctions (like legal defense, loss in reputation, etc.). Hence, to contrast a likely underestimation arising from the fact that we can rely only on the legally provided sanctions, the highest monetary legal sanction is considered, which in the relevant period was four times the evaded tax (for an incomplete tax report). Thus, recalling that the taxpayer must also pay the evaded tax, the value of parameter g has been set at 5.

The audit rate[5] in Italy in the relevant years has been around 1%; this is thus the value used for parameter p.

3.2 The Working of the Model

Figures 1 and 2 illustrate an application of our model by using 1990 parameters.



In Figure 1 the supply curve (payment C due) indicates the extra payment requested by the government, as a function of reported income, on the basis of the rules described in Table 1. Horizontal lines refer to the willingness to pay of two taxpayers characterized by different degrees of absolute risk aversion, namely 2.0×10^{-7} and 7.0×10^{-8}, in order to enter the amnesty. As the utility function considered is of CARA type, the willingness to pay does not vary with income, and depends only on p, g (whose values were set equal to 0.01 and 5 respectively) and α. As already clarified, the willingness to pay decreases as risk aversion increases. In Figure 1, for example, the more risk averse taxpayer is willing to make an amnesty payment of around one million Italian lire

[5]For data about controls, see Ministero delle Finanze, Ufficio di Statistica, *Accertamenti effettuati ai fini delle imposte dirette*, Roma, various issues.

(around 600 US dollars). His reported income can be located on the x axis of Figure 1, and is around 30 million of Italian lire.

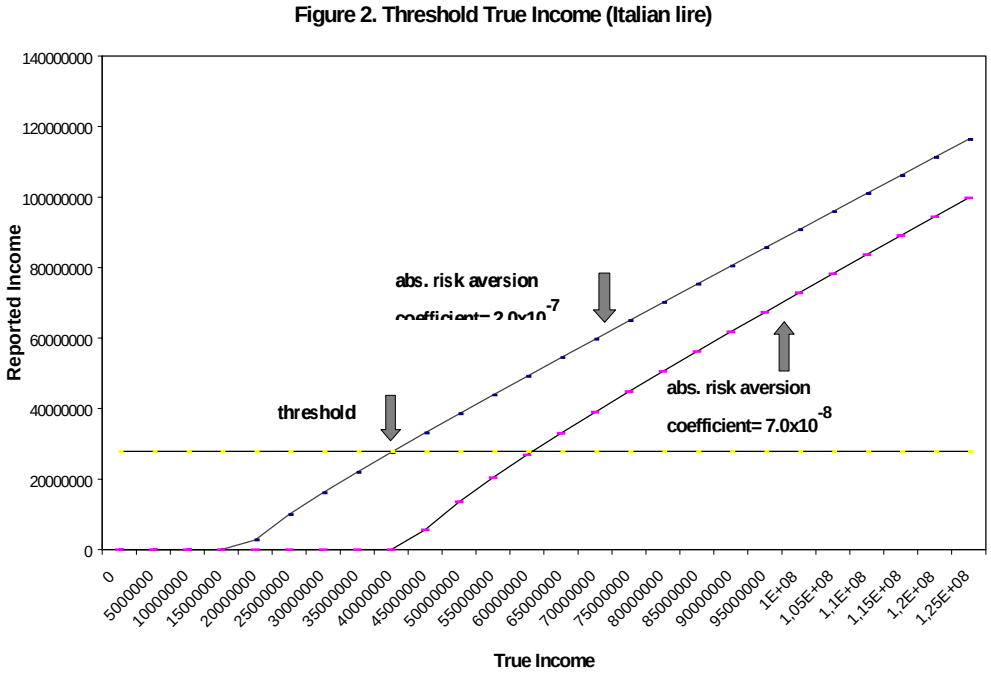


Figure 2 considers the same taxpayers as in Figure 1 and shows their optimal reported incomes, increasing in their true income. The intersection of the left optimal reported income curve with the actual reported income of 30 millions of Italian lire (as determined in Figure 1), indicates the threshold true income on the abscissa. Amnesty participation is also advantageous for other taxpayers, with the same reported income, but greater true income and smaller risk aversion, whose reported income curves lay on the right side of the threshold.

While Figures 1 and 2 are drawn for given levels of true income W and risk aversion α, data available only allow for estimates based on an inverse formulation of the model. Variables α and W actually are the unknowns[6], while variables C and X - the amnesty payment and the reported income - are known.

It is worth to remark that the 1991 tax amnesty incorporates a simple equity criterion. Table 1 shows that the requested amnesty payment C is a linear function of the tax payed,

$$C = k\gamma X^{*\delta}, \tag{10}$$

where coefficients k change with the bracket. By plugging (10) in (9), it is readily seen that the threshold percentage tax evasion is constant within each bracket, but with lower values for higher brackets. This favors a larger amnesty participation at higher reported income levels.

3.3 Estimation Results

For every amount C requested, it is possible to calculate threshold percentage evasion, and risk aversion needed for participation in the amnesty. Estimation of the model has however been performed

[6] As matter of fact, CARA assumption on utilities reduces the problem to just one unknown, the absolute risk aversion α.

only for some representative taxpayers. Table 2 refers to: a) a taxpayer endowed with average net reported income, and who enjoys average deductibles; b) a taxpayer endowed with average net reported business income[7]; c) a taxpayer endowed with average net reported self-employment income[8]. All the taxpayers considered paid a tax which belongs to the first bracket of Table 1.

The threshold evasion in the examples examined is always around 30% of the true income, as changes in tax parameters have a negligible effect. Threshold percentage evasion should become somewhat lower at higher reported income levels, because of the flattening of the C function (see Table 1).

To roughly assess the results, the calculated percentage evasion can be compared with available evasion estimates[9]. For the average Italian taxpayer and the relevant time period, the minimum evasion estimate is 19.9%, the maximum 36%. For self-employment and business income, the corresponding values are 42.9% - 58.1%. For income from wage or pension, evasion is relatively quite low (8.1% - 16.1%).

Table 2 ***Estimation results (1991 tax amnesty)***

	Case a		*Case b*		*Case c*	
Year	*Net reported income*	*Relative risk aversion*	*Net reported income*	*Relative risk aversion*	*Net reported income*	*Relative Risk aversion*
1985	*13.36*	*5.24*	*12.80*	*5.30*	*16.10*	*4.58*
1986	*14.18*	*5.95*	*13.20*	*6.07*	*17.60*	*5.58*
1987	*15.37*	*5.81*	*14.00*	*5.97*	*19.60*	*5.41*
1988	*16.74*	*5.66*	*15.50*	*5.79*	*23.10*	*5.15*
1989	*18.27*	*6.16*	*17.92*	*6.20*	*25.84*	*5.59*
1990	*19.45*	*6.17*	*18.20*	*6.29*	*28.05*	*5.57*

Note: income in millions of Italian lire.
Case a = taxpayer endowed with average net reported income, and who enjoys average deductibles.
Case b = taxpayer endowed with average net reported business income.
Case c = taxpayer endowed with average net reported self-employment income.

The results thus show, for the average taxpayer, a percentage evasion (needed to let the amnesty worth entering) which is close to the top values calculated by other studies, while for those endowed with the average business or self-employment income it is below the bottom value. In fact, amnesty was selective, and the participants were almost exclusively businessmen or self-employed. This fact is roughly consistent with the idea that the amnesty (whether intentionally or not) was targeted for specific high evasion groups.

As far as relative risk aversion is concerned, rather high values for the marginal entrants are estimated. One must remember however that these are higher bounds: taxpayers characterized by lower risk aversion coefficients would have net gains from participating in the amnesty.

[7] The average value is calculated without taking into account taxpayers who report zero income, and refers to entrepreneurs in ordinary tax regime (thus excluding cases of forfeit etc.).

[8] The average value is calculated without taking into account taxpayers who report zero income, and refers to all types of self-employment.

[9] For surveys, see [2] and [19].

A more direct indicator of the marginal participant's attitudes toward risk is obtained by dividing the amnesty payment C by the expected sanction $pg\gamma\left(W^{\delta}-X^{*\delta}\right)$. Payment C turns out to be 6.64 times the expected sanction in all cases considered (which is justified by risk aversion), while it is only one third of the evaded taxes.

4 Estimates for the 1994 Tax Amnesty

The amnesty provided by Law 656/1994 (*concordato di massa*) was reserved for entrepreneurs and the self employed. It has also been considered a success in terms of revenue and participation. Revenue reached about 5,000 million dollars (collected in the years 1995-1996; exchange rate 1998) and was higher than forecast. Rules regulating this amnesty provided for a cheaper entrance than in 1991 (mainly because there was no tying), and this may explain why the revenue was lower. The amnesty could be entered for the years 1987-1993, but for the years 1987-1990 (already covered by the 1991 amnesty) it was available only to those who had not participated in the previous amnesty on the basis of par. 38 of Law no. 413/1991.

Table 3 ***Estimation results for a taxpayer endowed with median business income from manufacturing industry (1994 tax amnesty)***

Year	***Net reported income***	***Percentage tax evasion***	***Relative Risk aversion***
1987	*19.32*	*31*	*7.62*
1988	*20.17*	*32*	*7.44*
1989	*22.98*	*33*	*7.79*
1990	*24.33*	*33*	*7.85*
1991	*25.31*	*33*	*7.17*
1992	*30.32*	*26*	*8.32*

To calculate C in this case, the government first estimated the taxpayer concealed income[10]*, and then asked the taxpayers to pay the income tax due on the basis of such estimation, plus the penalties, whose amount was however reduced below the ordinary level*[11]*. Also with reference to this amnesty, a rational taxpayer would react to the government proposal according the model presented in Section 2.*

Estimates are reported in Table 3. Results pertaining to threshold risk aversion and percentage evasion confirm those reached for the 1991 tax amnesty. Threshold percentage evasion is lower than that estimated by available studies for businessmen and self-employed. This fact is consistent with the success of the amnesty.

[10] Taxpayers were classified with reference to 12 types of economic activities, and to the type of tax regime (ordinary, forfeit etc.). Within each group, they were placed in increasing order of reported gross revenue, forming 20 classes. Members of each class were placed in increasing order of profitability rate (taxable income/gross revenue), forming 10 classes. An evaded income was calculated for each taxpayer depending on the difference between the average reported income of the profitability class immediately above his own and that of his class.

[11] The penalty due by amnesty participants was 25% of the evaded tax. If the sum to be paid according to this rule was greater than 5 millions Italian Lire, only half the amount in excess of 5 millions Italian Lire was due.

5 Assessing taxpayers risk-aversion

Estimated relative risk aversion can be compared with other available estimates (see Table 4): it turns out to be within the range of values reported in Table 4 and also within the boundaries usually considered in theoretical models[12], that is 0-10.

While thus results pertaining to amnesty participants seem reasonable, some problems arise with reference to taxpayers who refuse the amnesty, who, according to the model, should have a higher than the threshold risk aversion. Moreover, with reference to the values of p and g considered in Section 3, an infinite risk aversion would be needed to justify full compliance. Otherwise, full compliance would be chosen (given the value of p =0.01), if the perceived g assumed the value of 100, which seems incredibly high even accounting for non monetary costs born by the detected evader. Alternatively, one could explain full compliance considering that taxpayers who are motivated by moral sentiments could renounce to some benefit stemming from tax evasion. The sacrifice of a full complier would however be not negligible, amounting to at least 5% of his true income W[13]. A mix of the factors considered (that is above the threshold risk aversion, overvaluation of penalties and moral sentiments) could also explain full compliance.

Table 4 ***Estimates of the relative risk aversion coefficient***

Study	***Coefficient***	***Estimated from***
Weber (1970)	*2.4, 7.7*	*Consumer expenditures*
Friedman (1973)	*∼10*	*Health insurance*
Friend and Blume (1975)	*>10*	*Demand for risky assets*
Weber (1975)	*1.3 to 1.8*	*Consumer expenditures*
Farber (1978)	*3.0, 3.7*	*Union negotiations*
Hansen and Singleton (1978)	*0.35 to 1.0*	*Consumption, stock returns*
Wolf and Pohlman (1983)	*1, 4.5*	*Bill auctions*
Szpiro (1986)	*1.02,1.47*	*property/liability insurance*
Cecchetti and Mark (1990)	*>10*	*Asset pricing*
Ferson and Constantinides (1991)	*0-12*	*Consumer expenditures*
Cochrane and Hansen (1992)	*40-50*	*Asset pricing*

Source: updated from Table 1, p.157 of [22].

As Table 4 shows, very high values of relative risk aversion are not a new empirical finding: they have also been estimated by applying EU models to financial markets. There is however a burgeoning literature about the "equity premium puzzle", which tries to reconcile high observed equity premia with lower and more tenable risk aversion coefficients. A promising approach seems that of modifying the description of choice under uncertainty. We follow the same path in trying to cope with the "full compliance puzzle": in the following section the model is modified according to EURDP (Expected Utility with Rank Dependent Probability) approach.

[12] Epstein and Zin [11] quote a tradition concerning relative risk aversion, which should not be greater than 10.

[13] This amount, referred to the most risk averse taxpayer considered in Table 3, is calculated on the basis of the sum of money that he should receive in order to renounce his optimal evasion while keeping the same utility level.

6 The EURDP approach

EURDP assumes that the agent arranges the outcomes of a lottery in increasing order, and has a perception of the probability of their occurrence deformed according to their rank. With reference to lotteries with two possible outcomes w' and w'' with probability $1-p$ and p respectively, if $w' \geq w''$, then the EURDP function is given by $V(w', w'', p) = f(1-p)u(w') + [1 - f(1-p)]\, u(w'')$, where u is an utility function and f is a continuous, strictly increasing and onto probability transformation function $f : [0,1] \to [0,1]$. In tax compliance problems, the outcome with higher rank w' is the case when no detection occurs (with probability $1-p$), while the outcome with lower rank w'' is the case when the taxpayer is get "caught" (with probability p).

To modify the model considered in 2 according to EURDP, we construct the function V using the constant absolute risk aversion utility $u(w) = -e^{-\alpha w}$ and the probability transformation given by the function

$$f(p) = \frac{p^{0.56}}{\left[p^{0.56} + (1-p)^{0.56}\right]^{\frac{1}{0.56}}}, \tag{11}$$

whose parameters have been estimated by Camerer and Ho [5]. EURDP implies risk aversion if the utility function is concave, while the probability transformation function is convex. Estimates presented in this section are consistent with the risk aversion assumption.

The objective audit probability considered in Section 3 has thus been transformed on the basis of (11) to keep into account rank dependency. This transformation brings the audit rate p from 1% to a deformed value of 12%. As a result, with reference to data pertaining to the 1991 Italian tax amnesty, estimated threshold relative risk aversion assumes values between 2 and 3, which better conform with the standard value (around 2) mainly used in the literature for this parameter. However, the estimated threshold tax evasion would be around 16%, a value lower than the currently estimated average Italian tax evasion (19.9%-36%) and within the range of the currently estimated average tax evasion for employees (8.1% - 16.1%). Even if the distribution of tax evasion is not known, unless it is extremely skewed, one would expect in this case a large participation to the amnesty, larger than the one really observed (which was less than 10% of the taxpayers). One should also observe some participation by employees (which was instead about nil).

With reference to the indicator of the marginal participant's attitudes toward risk, calculated by dividing the amnesty payment C by the expected sanction (on the basis of the objective probability), it would assume in this case a value around 16. On the other hand, payment C would be 80% of the evaded taxes. Therefore, evading and participating in the amnesty would be in this case, for the marginal participant, not as a good deal as if EU applied, and this does not match with widely shared beliefs about the 1991 amnesty considered. In sum, it seems that the EURDP approach at least does not improve upon the EU one.

EURDP however explains better than EU the behavior of the over-the threshold or full compliers (who do not participate in the amnesty). With EURDP, provided the perceived audit probability is 12%, full compliance would arise with $g = 8.3$. Otherwise, with $g = 5$, moral sentiments could explain full compliance. In fact, by renouncing evasion, the marginal amnesty participant looses at most 1% of his income[14].

With reference to the 1994 tax amnesty, the resort to EURDP reduces estimated relative risk aversion and tax evasion in a way that parallels the results already mentioned for the 1991 tax amnesty. The 1994 amnesty was not offered to employees, and so their reaction cannot be observed.

[14] See note 9. The value is referred to the less risk averse taxpayer considered in Table 2.

7 Concluding Remarks

Participating in a tax amnesty, evaders avoid expected sanctions. As long as they are risk averse, the fixed amount that they accept to pay is higher than the expected payment that the government could collect (at a cost) from them after auditing them and detecting their evasion. Thus amnesties of the type modelled in the paper increase government revenue. As Chu [8] has shown, a marginal introduction of a regime that allows taxpayers to avoid tax audits if they make a fixed payment can be Pareto-improving. The type of amnesty presented in this paper induces also a self-selection of taxpayers which is similar to that of plea bargaining, selecting more "guilty" evaders.

Both plea bargaining and tax amnesties however may imply equity problems, as they introduce some kind of discrimination. Specifically, the 1991 tax amnesty has a regressive bias, as taxpayers who reported higher incomes and belongs to higher brackets can enter the amnesty at lower percentage tax evasion levels. Moreover, in both amnesties taxpayers with the same true income may pay different total amounts according to their attitudes toward risk.

From an efficiency point of view, if one introduces time discounting and taxpayers anticipation, amnesties may increase tax evasion of prospective participants, with effects upon total tax revenue that could turn from positive into negative.

The Italian experience over the last twenty years has been characterized by frequent tax amnesties; thus the assumption that amnesties are not at all anticipated by taxpayers is probably too severe. Nevertheless, estimation of a simple EU model that ignores anticipation provides results roughly in accordance with available evidence. We are planning to test in a further development of this research the sensitivity of the results to changes in the assumptions pertaining to risk aversion, from CARA (Constant Absolute Risk Aversion) to CRRA (Constant Relative Risk Aversion).

The results reached so far challenge the widely shared opinion that all stylized facts about taxpayer behavior are in sharp contrast with EU. For example Alm and Beck [1] maintain that " taxpayers would have to exhibit risk aversion far in excess of anything ever observed for compliance predicted by expected utility theory to approximate actual compliance" (p. 442). As a matter of fact, also in our expected utility model, estimated with Italian tax enforcement parameters, full compliance could arise only with infinite risk aversion. However, the same EU model implies reasonable relative risk aversion coefficients for amnesty participants and conforms to available evidence as far as taxpayers reactions to amnesties are concerned.

To solve the puzzle of tax compliance, some authors (see, e.g., [3]) have suggested the use of non-expected utility approaches, like EURDP. In order to describe tax amnesty participation however, this approach does not seem to improve upon EU. On the other hand EURDP, coupled with some "moral sentiment" that fills in the tax evasion gap left, could in our model motivate over-the threshold or full compliance (and thus no amnesty participation).

It seems that models that are better able to predict the behavior of compliers (like EURDP) do not work as well when applied to evaders. Also in experimental economics there is evidence suggesting that some models, which are able to describe behavior within specific institutions (e.g. markets) perform worse or do not work at all in other circumstances (e.g. public good games). Schram [21] rationalizes this fact by considering that agents are heterogenous and are guided by different "motivations", as psychologists mainly maintain. Agents choices are influenced by their beliefs about what they expect others do and by the institutional environment. Italian amnesties would then turn out to be devices that select (and arguably foster) rational and selfish behavior.

A Appendix 1

Table 5 ***Parameters of the tax function (1) for years 1985-1992***

Year	γ	δ
1985	*0.002249*	*1.274515*
1986-1988	*0.001441*	*1.292886*
1989	*0.001537*	*1.282436*
1990	*0.001508*	*1.282429*
1991	*0.001739*	*1.279154*
1992	*0.001615*	*1.285728*

Note: O.L.S. estimation on logarithms of data in Italian Lire.

For each income bracket the income tax due can be described by the function $T(X) = t_i X - d_i$, where t_i is the bracket's marginal tax rate and d_i is the deduction that must be applied so that the share of income below the bracket threshold be taxed at lower rates. The tax due, as a function of the net taxable income, can thus be represented by as many linear segments as the number of income brackets. OLS estimation technique (with variables in logarithms) was used to interpolate the six tax schedules applied in the period for which the amnesties considered in this paper were available.

References

[1] Alm, J. and W.Beck, Tax Amnesties and Tax Revenue, *Public Finance Quarterly* **18**: 433-53, 1990.

[2] Bernasconi, M., Evasione fiscale in Italia ed evoluzione recente degli strumenti di contrasto, in L. Bernardi (ed.), *La finanza pubblica italiana - Rapporto 1995*, Bologna, Il Mulino: 111-35, 1995.

[3] Bernasconi, M., Tax Evasion and Orders of Risk Aversion, *Journal of Public Economics* **67**: 123-34, 1998.

[4] Beron, K. J., Tauchen, H. V. and A. D. Witte, The Effect of Audits and Socioeconomic Variables on Compliance, in J. Slemrod (ed.), *Why People Pay Taxes*, Ann Arbor, University of Michigan Press: 67-89, 1992.

[5] Camerer, C.F. and T. H. Ho, Violations of the Betweennenes Axioms and Nonlinearity in Probability, *Journal of Risk and Uncertainty* **8**: 167-96, 1994.

[6] Cassone, A. and C. Marchese, Tax Amnesties as Special Sales Offers: the Italian Experience, *Public Finance, Finances Publiques* **50**: 51-66, 1995.

[7] Cecchetti, G. S. and N. C. Mark, Evaluating Empirical Tests of Asset Pricing Models: Alternative Interpretations, *American Economic Review Papers and Proceedings* **80**: 48-51, 1990.

[8] Chu, C. Y., Plea Bargaining with the IRS, *Journal of Public Economics* **41**: 319-33, 1990.

[9] Cochrane,J. H. and L. P. Hansen, Asset Pricing Explorations for Macroeconomics, *NBER Macroeconomics Annual*, Cambridge, MA: NBER, 1992.

[10] Epstein, L. G., Behaviour under Risk: Recent Developments in Theory and Applications, J. J. Laffont (ed.), *Advances in Economic Theory: Sixth World Congress of Th eEconometric Society,* Vol. II, Cambridge, Cambridge University Press: 1-63, 1992.

[11] Epstein, L. G. and S. E. Zin , First Order Risk Aversion' and the Equity Premium Puzzle, *Journal of Monetary Economics* **26**: 387-407, 1990.

[12] Farber, H. S., Individual Preferences and Union Wage Determination: The Case of the United Mine Workers, *Journal of Political Economy* **86**: 923-42, 1978.

[13] Ferson, W. E. and G. M. Constantinides, Habit Persistence and Durability in Aggregate Consumption: Emprical Tests, *Journal of Financial Economics*, **29**: 199-240, 1991.

[14] Friedman, B., Risk Aversion and the Consumer Choice for Health Insurance, *Review of Economics and Statistics* **56**: 209-14, 1973.

[15] Friend, I. and M. E. Blume, The Demand for Risky Assets, *American Economic Review* **65**: 900-22, 1975.

[16] Grossman, G. M. and M. L. Katz, Plea Bargaining and Social Welfare, *American Economic Review* **73**: 749-57, 1983.

[17] Hansen, L. P. and K. J. Singleton, Generalized Instrumental Variables. Estimation of Nonlinear Expectations Models, *Econometrica* **50**: 1269-86, 1982.

[18] Loehman, E., Testing Risk Aversion and Nonexpected Utility Theories, *Journal of Economic Behavior & Organization* **33**: 285-302, 1998.

[19] Monacelli, P.,Problemi di stima dell'evasione fiscale: una rassegna dei metodi e degli studi effettuati per l'Italia, *Economia pubblica* **36**: 103-126, 1996.

[20] Siegel, F. W. and J. P. Hoban, Relative Risk Aversion Revisited, *Review of Economics and Statistics* **64**: 481-87, 1982.

[21] Schram, A., Sorting Out the Seeking: The Economics of Individual Motivations, paper presented at *the European Public Choice Society Meeting,* April 29-May 2, Goteborg, 1988.

[22] Szpiro, G. G., Measuring Risk Aversion: An Alternative Approach, *Review of Economics and Statistics* **68**: 156-59, 1986.

[23] Weber, W. E., The Effect of Interest Rates on Aggregate Consumption, *American Economic Review* **60**: 591-600, 1970.

[24] _____, Interest Rates, Inflation and Consumer Expenditures, *American Economic Review* **65**: 843-58, 1975.

[25] Wolf, C. and L. Pohlman, The Recovery of Risk Preferences from Actual Choices, *Econometrica* **51**: 843-50, 1983.